Climate Change Projections for Ontario

Joshua Palmer, Daniel A. Herms and Scott E. Maco

The Davey Climate Change Fact Sheet Series projects the future impacts of climate change in our industry over the next 30-70 years, with emphasis on changes in temperature, precipitation, storm intensity, tree health, pest pressure, wildfire, and worker stress. Temperatures across Canada have risen 1.7°C since 1948, which is twice the global average. By the end of the century, temperatures are expected to increase between 1.8-6°C, with future patterns of greenhouse gas emissions providing the largest source of uncertainty. The Intergovernmental Panel on Climate Change (IPCC) predicts future climates based on modeling for different emissions scenarios, called "Representative Concentration Pathways (RCP)." This fact sheet focuses on changes expected to occur in Ontario based on lower (RCP2.6), intermediate (RCP4.5), and higher (RCP8.5) emissions scenarios. Currently, global patterns of fossil fuel consumption correspond most closely with the high emission scenario, while the lower and intermediate emission scenarios will require significant mitigation measures yet to be implemented.

Heightened temperatures with warming waters

Like much of Canada's most densely populated regions, southern Ontario is warming at twice the global rate, while its northern sections are warming even faster. Between 1948 and 2016, average annual temperatures in Ontario have warmed by 1.3°C, with all seasons experiencing at least 1°C of warming. The most significant warming has occurred during winter, with average annual temperatures now 2°C higher than they were in 1948.

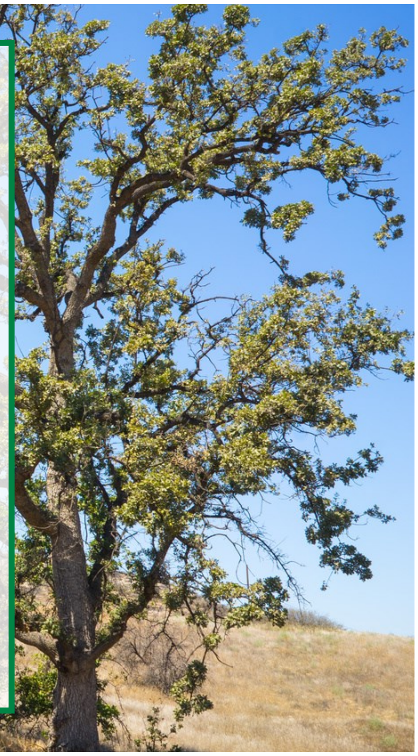
These trends are expected to continue over the next several decades. Under the higher emissions scenario, Ontario is projected to warm an additional 2.3°C by 2050, and 6.3°C by 2100. If emissions can be limited to the RCP2.6 scenario, additional warming would still range from 1.5°C to 1.7°C. Under the higher emissions scenario, the average annual temperature of Toronto is projected to increase by 7.3°C from the 1971-2000 baseline by the end of the century.

Planta Greenhouses

Warmer temperatures will lead to earlier snowmelt, more extreme heat days, and a longer growing season. In Ontario generally, under the higher emissions scenario, the number of hot days exceeding 30°C is projected to increase by approximately 9 and 38 by 2050 and 2100, respectively. In Toronto more specifically, under the higher emissions scenario, the annual number of hot days and the number of very hot days (exceeding 35°C), will increase from around 11 days and 1 day (1971-2000), respectively, to 52 days and 14 days, respectively, by the end of the century. Conversely, the number of days below -20°C in Toronto is projected to decline from an average of 10 days per year to as few as 0-3 days under the higher emission scenario. The frost-free season lengthened by 20 days from 1948-2016, and the length of the growing season in Ontario could lengthen by roughly 44 days by 2100 as the climate continues to warm.

Heightened temperatures with warming waters cont. Hardiness zones in Canada differ slightly from USDA plant hardiness zones. While the USDA zones range from 0a to 13b and are based on the average lowest temperatures experienced in a region each year, Canadian hardiness zones range from 0a to 9b, integrating seven different climate conditions including rainfall, frost-free periods, maximum snow depth, average temperatures, and wind, among others.

Ontario spans eight different hardiness zones (0-7), with each subregion possessing unique climate factors that have significant impacts on growing conditions. Compared to the original zones and maps constructed from 1931-1960, zones for 1981-2010 have increased for some of Ontario's largest population centers, including a shift of 6a to 7a for the Toronto metropolitan area. Overall, hardiness zone designations will continue to change with the climate, greatly impacting the tree species that inhabit a particular region.



Increasing precipitation and storm intensification

Annual precipitation across Ontario has also increased, as have high intensity rainfall events and associated flooding. Between 1948 and 2012, Ontario's annual precipitation increased by 10%, with the greatest increases coming in spring and autumn. Further increases are projected, with precipitation predicted to increase by as much as 17% by the end of the century under the higher emissions scenario.

Between 1900 and 2012, the number of days with heavy rainfall, 7mm of precipitation per hour or more, in southern Canada and Ontario has increased by approximately 1.6 days. The frequency of heavy precipitation events is projected to continue to increase, with short-duration rainfall extremes becoming more intense, placing stress on existing stormwater management infrastructure. Floods from spring snow melt will likely decrease, but flash floods will become more common. Both the snow and frost season are expected to shorten by the end of the century, as compared with the average for 1995-2014.

In Toronto, by the end of the century, total annual precipitation is projected to increase between 3 and 31% under the higher emissions scenario, with the large variation reflecting uncertainty in precipitation models. One-day maximum precipitation associated with more frequent and intense storms is expected to increase 60-100%. Higher precipitation levels can adversely affect ecosystem, infrastructure, water quality, and human health.

Threatened and thriving: Consequences of climate change on trees in Ontario

Ontario is composed of two primary forest ecozones, the Boreal Shield and the Mixedwood Plains. Significant increases in precipitation east of Lake Winnipeg in Manitoba into Ontario and the Eastern Borealis are projected to limit droughts even under warmer temperatures. In concert with a warmer and longer growing season, increased precipitation is projected to increase forest productivity, even as some species decline in abundance. However variability in precipitation patterns caused by climate change is expected to increase the potential for drought conditions across other parts of the province, most notably in southern Ontario, resulting in increased tree decline and mortality. Spruces and birch may be displaced by pine and aspen in drier regions, with black spruce and jack pine severely impacted in central Ontario.

The Mixedwood Plains ecoprovince of southern Ontario is characterized by high species diversity, including Ohio buckeye, black walnut, sycamore, blue ash, tulip tree, and bitternut hickory. However, deforestation has reduced forest cover in this region by 80%. By 2100, climate zones suitable for hardwood species may shift northward as much as 250-650 km. Tree species unable to migrate fast enough to keep pace with changing climatic conditions may experience extirpation.

The frequency of wildfires and the length of the fire season are also projected to increase in Ontario. Overall, the total area burned by wildfires is expected to expand by 50-300% by 2080, mostly in the northwest of the province.


Emerald ash borer damage

More outbreaks by forest insects

Forests in Ontario are threatened by a variety of insects and diseases, with increases in both the frequency and severity of pest outbreaks in the region. Butternut canker has decimated 80% of the country's butternut walnut trees, mostly in Ontario and Quebec, and forest tent caterpillar periodically defoliates millions of hectares of trembling aspen, oak, ash, maple and white birch in Ontario, Quebec, and Alberta.

Warming temperatures caused by climate change are impacting the distribution and abundance of key tree-feeding insects. In northern Ontario, for example, climate change is predicted to increase defoliation and mortality of spruce and fir caused by eastern spruce budworm. Likewise, warmer minimum temperatures are projected to increase frequency and magnitude of forest tent caterpillar outbreaks in the more northerly regions of Ontario. Models predict that mountain pine beetle and southern pine beetle may also eventually spread to Ontario.

In 2021, Ontario experienced its largest recorded outbreak of spongy moth, which defoliated an area the size of Lake Ontario. Introduced to the United States in 1869, the invasive spongy moth first expanded its range into Canada in the 1960s. As temperatures increase and precipitation becomes more variable, the Entomophaga maimaiga fungus that often keeps spongy moth populations at low levels may become less effective. Warming weather during the winter months will increase survival of overwintering eggs. However, this could be counteracted in some areas if reduced snow depth contributes to greater egg mortality due to a lack of insulation. Emerald ash borer is also projected to spread northward as fewer days of extreme cold increase overwintering survival. First discovered in Ontario in 2002, the invasive species feeds on all ash species in Ontario and has killed tens of millions of trees across southern Canada as it continues to spread farther north into the distribution of black ash.

Climate effects on human health and wellness

As extreme heat events become longer, more frequent, and more intense, the risk of heat-related illness will also increase. Existing health conditions will be exacerbated too, contributing to an increased number of deaths. Conversely, warmer winters are projected to decrease mortality from extreme cold. Poor air quality is a serious public health issue in Ontario as well, with smog and air pollution aggravating respiratory illnesses such as asthma and cardiovascular disease. By 2050, Toronto public health predicts that air-pollution related deaths could increase by as much as 20 percent due to climate change. Heat waves will increase the length of the hay fever season and increase the frequency of wildfires and associated degradation of air quality by smoke.

Warmer weather and increased precipitation will also contribute to the spread of disease and the northern shift distribution of water-borne pathogens. Ticks carrying Lyme disease, for example, are spreading quickly throughout central Canada. The mosquito vectored West Nile virus is projected to spread farther north in Ontario as temperatures increase. The probability of these and similar events will increase as the climate continues to change.

Sources:

Alladin, E. (2022, January 30). *The differences between us and Canadian Plant Hardiness Zones*. Earth Undaunted. Retrieved from https://earthundaunted.com/the-differences-between-us-and-canadian-plant-hardiness-zones/

Brissette, F., & Poulin, A. (2021, December 7). *What climate change means for Southern Ontario and Québec*. The Conversation. Retrieved from https://theconversation.com/what-climate-change-means-for-southern-ontario-and-quebec-166920

Connolly, A. (2019, September 26). *Here's how climate change will impact the region where you live - national*. Global News. Retrieved from https://globalnews.ca/news/5918981/climate-change-impact-across-canada/

Ford LB. (2009, January). Climate change and health in Canada. Mcgill J Med.12(1):78-84. PMID: 19753294; PMCID: PMC2687921.

Government of Canada. (2023). *Adapting to climate change: The story of invasive insects in Canada's forests*. Retrieved from https://www.nrcan.gc.ca/our-natural-resources/forests/state-canadas-forests-report/adapting-climate-change-the-story-invasive-insects-canadas-forests/24152

McKenney D. W., Pedlar J. H., Lawrence K, Papadopol P, Campbell K, Hutchinson M. F. (2014, April). Change and Evolution in the Plant Hardiness Zones of Canada, *BioScience*, Volume 64, Issue 4, Pages 341–350, https://doi.org/10.1093/biosci/biu016

Johnston, M., Vulnerability of Canada's tree species to climate change and management options for adaptation: An overview for policy makers and Practitioners (2009). Canadian Council of Forest Ministers.

Morand, A., & Douglas, A. (2016). *Forests in a Changing Climate: Impacts and Adaptation in Ontario*. Retrieved from https://climateontario.ca/doc/RACII/National_Assessment_Syntheses/Posters/Forests_in_a_Changing_Climate-Impacts_and_Adaptation_in_Ontario.pdf

Pevach Corp. (2019, July 19). *9 insects and diseases destroying Canada's trees and forests*. Retrieved from https://pevachcorp.com/9-insects-and-diseases-destroying-canadas-trees-and-forests/

Plouffe, D., Blondlot, A., Bourgeois, G., Saguez, J., & Allen, C. (2020). *Crop pests and climate change*. Climate Data Canada. Retrieved from https://climatedata.ca/case-study/the-brown-marmorated-stink-bug-in-quebec/

Toronto and Region Conservation Authority (TRCA). (2022). *Taking action on climate change in the Toronto region*. Retrieved from https://trca.ca/climate-change-impacts-gta/#local

University of Waterloo. (2018, May 18). *Climate change broadens threat of emerald ash borer*. Retrieved from https://uwaterloo.ca/news/climate-change-broadens-threat-emerald-ash-borer

Venette, R. C., & Abrahamson, M. (2010). *Cold hardiness of emerald ash borer, Agrilus planipennis: A new perspective*. Retrieved February 8, 2023, from https://www.nrs.fs.usda.gov/pubs/45307

Vincent L.A., Zhang X., Mekis E., Wan H., & Bush E.J. (2018). Changes in Canada's Climate: Trends in Indices Based on Daily Temperature and Precipitation Data, Atmosphere-Ocean, 56:5, 332-349, DOI: 10.1080/07055900.2018.1514579

Zhang, X., Flato, G., Kirchmeier-Young, M., Vincent, L., Wan, H., Wang, X., Rong, R., Fyfe, J., Li, G., Kharin, V.V. (2019). Changes in Temperature and Precipitation Across Canada; Chapter 4 *in* Bush, E. and Lemmen, D.S. (Eds.) Canada's Changing Climate Report. Government of Canada, Ottawa, Ontario, pp 112-193.